Universitat Autònoma de Barcelona

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Biologia 2019

Bd *vs.* Bsal

comparison and main differences between two killer fungi

CONTEXT

Amphibians are experiencing massive population declines globally. A major driver is Chytridiomycosis, an emerging infectious disease that affects the vital function of amphibian's skin caused by the fungal pathogens *Batrachochytrium dendrobatidis* (*Bd*) and *Batrachochytrium salamandrivorans* (*Bsal*).

AIM

The aim of this review is to show the main differences between these two fungi in order to predict the future of Chytriodiomycosis better.

MAIN DIFFERENCES

Batrachochytrium dendrobatidis

Phylogeny

- Ancestral population origin: Korean peninsula

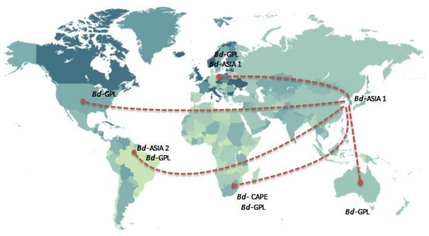

Fig. 1: *Bd* geographical origin and dispersion. The main diverged lineages for *Bd* today are *Bd*-GPL, Bd-CAPE, *Bd*-ASIA-1 and *Bd*-ASIA-2/Bd-BRAZIL. Of the four, *Bd*-ASIA-1 presents the genetic hallmarks of the ancestral *Bd* population that emerged in 20th century.

Developmental morphology

- No formation of germ tubes in vitro
- Rare formation of colonial thalli

Pathology

- Hyperkeratosis of stratums corneum and granelosum
- Erosion of stratum corneum
- Hyperplasia of stratum spinosum

Ecology

- Optimal growth temperature: 17-25 ºC
- Lethal temperature: 30 ºC and higher
- Host preferences: Anurans, urodeles and caecilians

Clinical signs

- Excessive shedding
- Erythema
- Discoloration

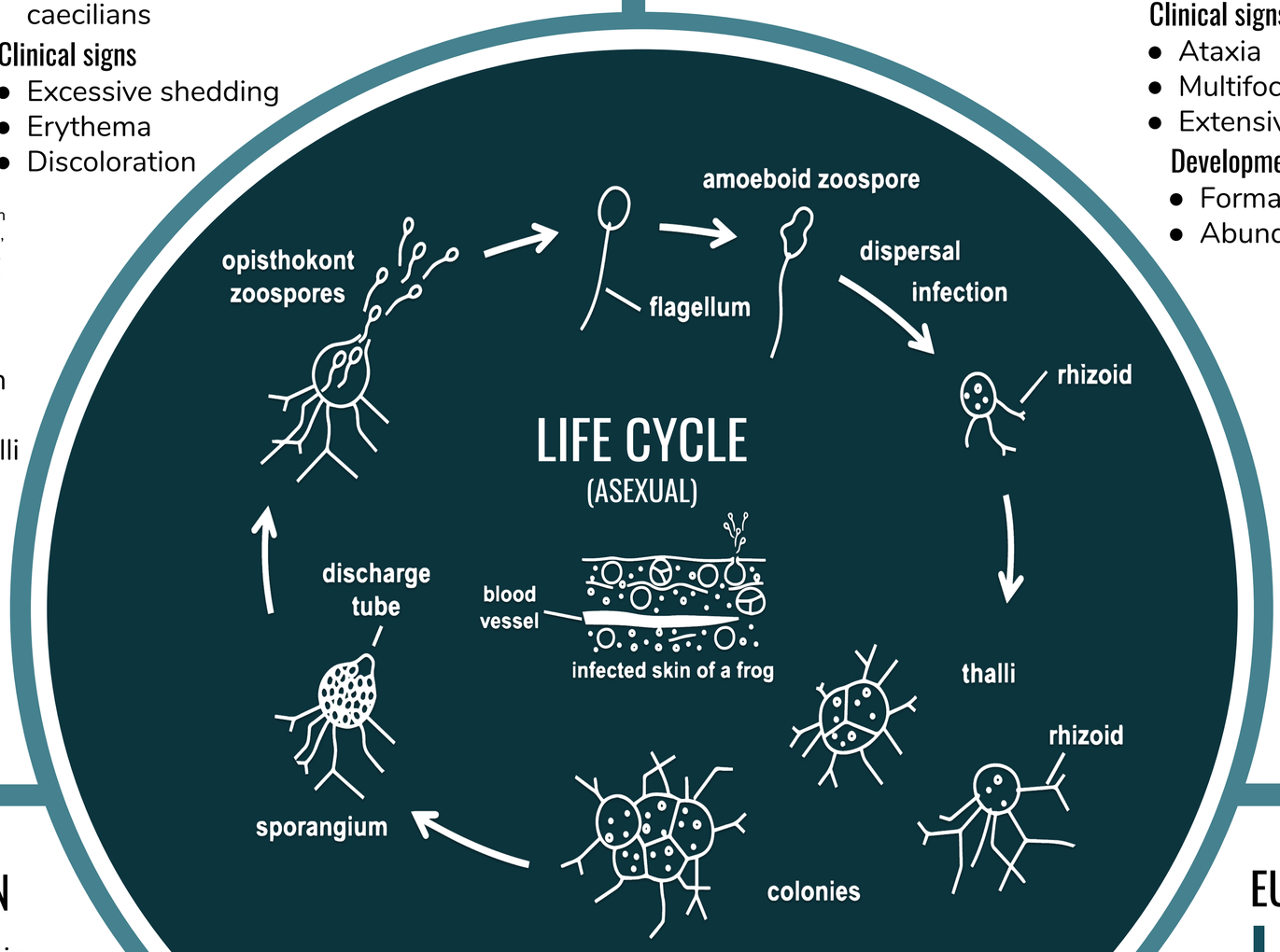

Fig. 3: *Bd*'s asexual life cycle in nature. Reprinted from Wikipedia by M. Piepenbring, 2015. Like most of Chytridiomycota phylum members this cycle consists in two life stages: a sessile reproductive thallus with one or more zoosporangium, and motile uniflagellated zoospores that are released from the zoosporangium. *Bsal*'s life cycle has not been described yet, but it seems to be similar to *Bd*'s one.

Batrachochytrium salamandrivorans

Phylogeny

- Ancestral population origin: East Asia

Ecology and life cycle

- Optimal growth temperature: 10-15 ºC
- Lethal temperature: 25 ºC and higher
- Host preferences: Urodeles exclusively

Clinical signs

- Ataxia
- Multifocal superficial erosions
- Extensive epidermal ulcerations

Developmental morphology

- Formation of germ tubes in vitro
- Abundant formation of colonial thalli

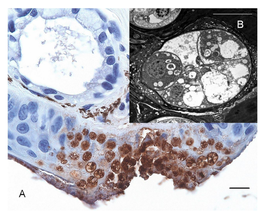

Fig. 2: Intracellular colonial thalli of *Bsal* in epidermal cell layers (A). Martel, A. (2013). *Batrachochytrium salamandrivorans sp. nov. causes lethal chytridiomycosis in amphibians.* PNAS.110. 10.1073/pnas

Pathology

- No hyperkeratosis or hyperplasia
- More erosive lesions
- Necrosis of the keratinocytes

GLOBAL DISTRIBUTION

8.008 amphibian species
520 with Chytridiomycosis
4 species gone extinct

EUROPEAN DISTRIBUTION

137 amphibian species
20 affected by *Bd*
5 affected by *Bsal*

Bd's global distribution

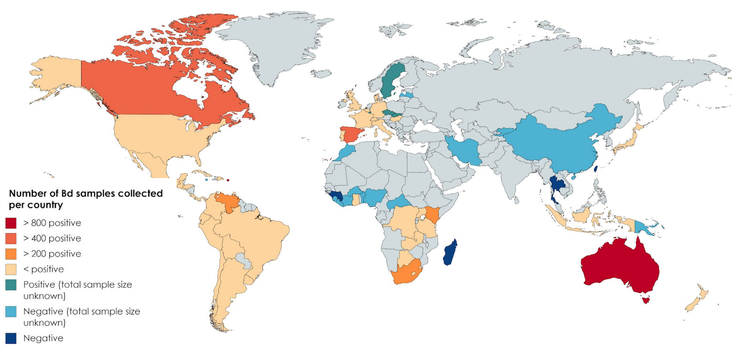

Fig. 4: Map of *Bd*'s global distribution. Reprinted from *Bd*-Maps.net by D.M. Aanensen, 2019. According to this map. *Bd* has been detected in Australia, New Zealand and Tasmania; throughout the entire American continent; the Caribbean islands; Europe; Central and South Africa and some Asian countries like Indonesia, Japan and North and South Korea.

Bsal's global distribution

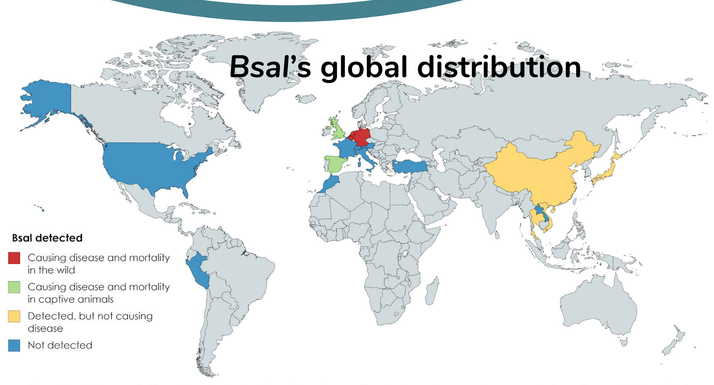

Fig. 5: Map of *Bsal*'s global distribution. *Bsal has been detected in* East Asia (China, Vietnam, Thailand and Japan), where is endemic; has been detected in the wild causing disease and mortality in Netherlands, from where it spread to Belgium and Germany; and causing disease and mortality in captive animals in Germany, Spain and the UK.

Bd and Bsal's European distribution

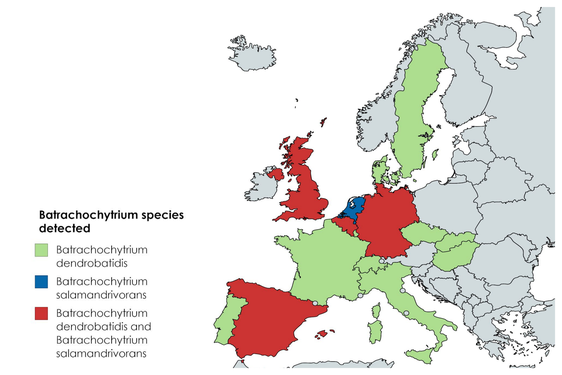

Fig. 6: Map of *Bd* and *Bsal*'s Europen distribution. Europe is the only continent where both fungi coexist as pathogens. Specifically the countries where we can find both pathogens are Germany, Spain and the UK.

CONCLUSIONS

Although its multiple lineages and its rapid spread, some important findings for *Bd* have occurred in the last years, like the recent discovery of its original lineage or its sexual cycle evidences. On the other hand, *Bsal* is still a quite unknown pathogen due to its recent arrival in Europe. We have managed to determine some differences between the two of them that can help us to understand how the disease spreads and develops, but it is undeniable that we still have to dig deeper into **(1) their biology, (2) their infection process**, **(3) mechanisms driving the infection dynamics**, **(4) possible carriers and vectors**, **(5) distribution and occurrence** and **(6) pet trade regulation.**

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CONSULTED DATABASE

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